Joint Distributed Engineering Plan
Support to
Single Integrated Air Picture System Engineering

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Outline

- What is the SIAP?
- What is JDEP?
- JDEP Support to SIAP Systems Engineering

The confusing air picture problem

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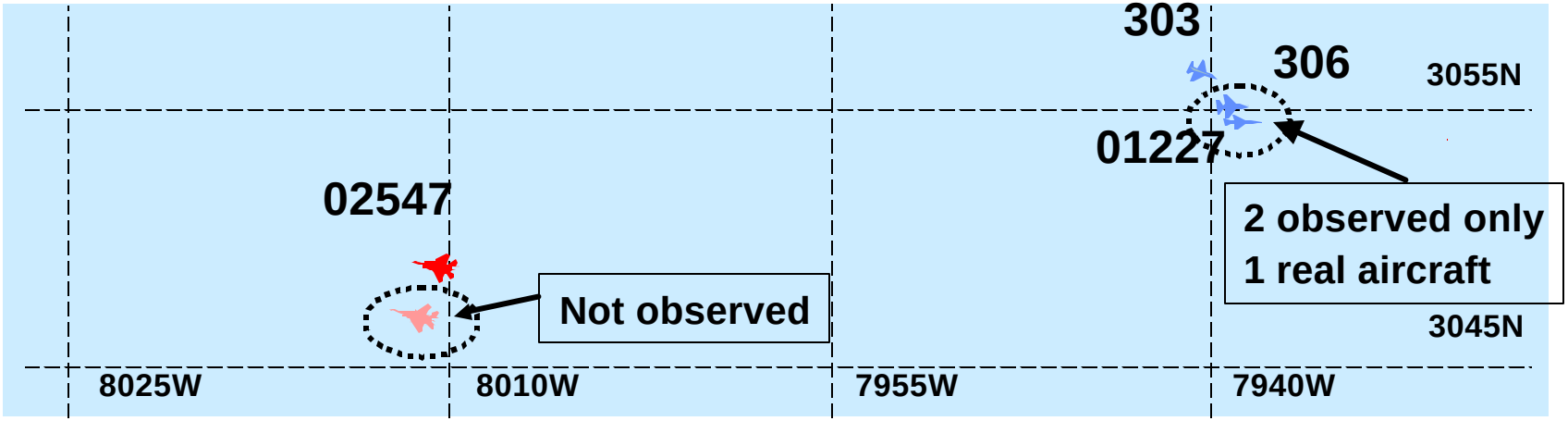
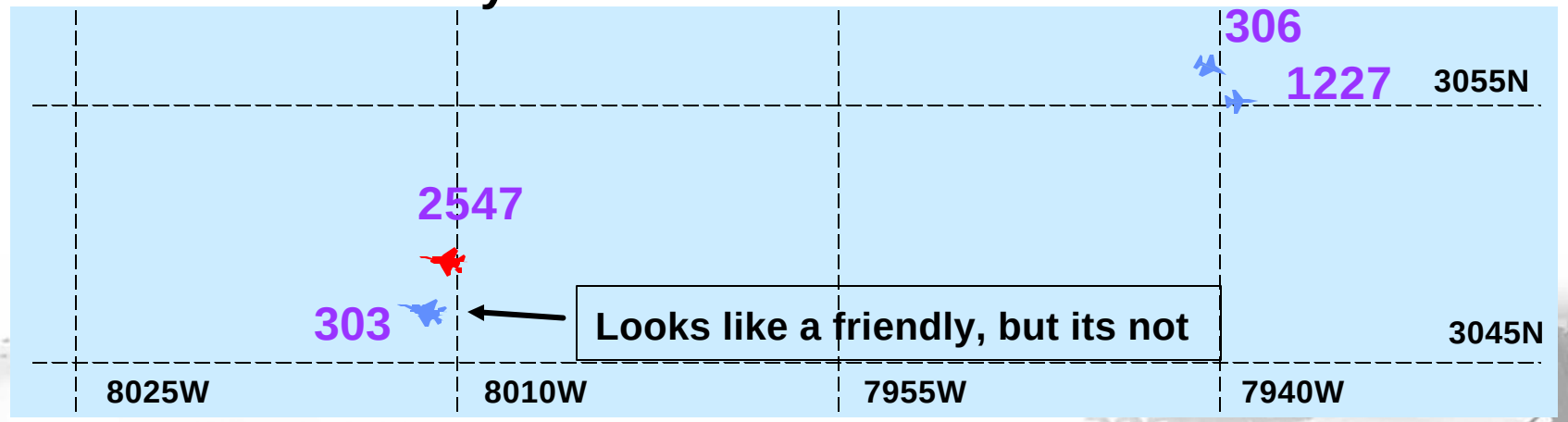
System A's View of World



System B's View of the World



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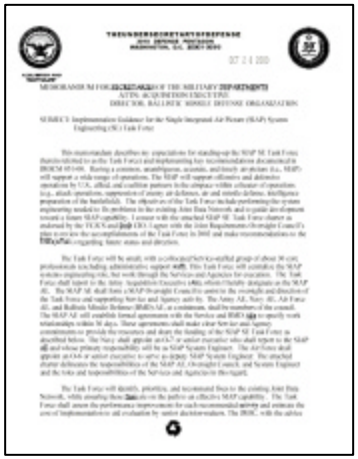
The Operational Mandate

SIAP SE TF Charter & Implementation Guidance (26 Oct 00)



- **Stand up a small, collocated Task Force staffed by the Services to develop/maintain a disciplined SE process**
- **Army Acquisition Executive (AE)**
- **Navy Lead System Engineer**
- **Air Force Deputy**

Warfighting benefit improvement recommendations to the JROC

An incremental approach

TBD — Block "n"

Improve efficiency/throughput
Improve gateways and beyond LOS — Block 2

Improve accuracy and commonality
Improve combat ID capability — Block 1

Reduce dual tracks/operator confusion — Block 0

Stepping stones to increased Joint warfighting capability

SIAP Analysis Team (SAT)

- SAT consists of service and joint subject matter experts.
- Performs tool/process development, planning, data collection, post event root cause analysis, and reporting functions
- Organized around Block issues and infrastructure requirements e.g. WGs consist of
  - Time
  - DR
  - CRS
  - M&S
  - Live event

SIAP Analysis Team (SAT) provides cross-service IADS analytical expertise to support engineering decision-making.

Metrics: SIAP Attributes

- **Completeness:** The air picture is complete when all objects are detected, tracked and reported.
- **Clarity:** The air picture is clear when it does not include ambiguous or spurious tracks.
- **Continuity:** The air picture is continuous when the tracks are long lived and stable.
- **Kinematic Accuracy:** The air picture is kinematically accurate when the position and velocity of a track agrees with the position and velocity of the associated object.
- **ID Completeness:** The ID is complete when all tracked objects are labeled in a state other than unknown.
- **ID Accuracy:** The ID is accurate when all tracked objects are labeled correctly.
- **ID Clarity:** The ID is ambiguous when a tracked object has two or more conflicting ID states.
- **Commonality:** The air picture is common when the tracks held by each participant have the same track number, position, and ID.

Support to SIAP SE Process

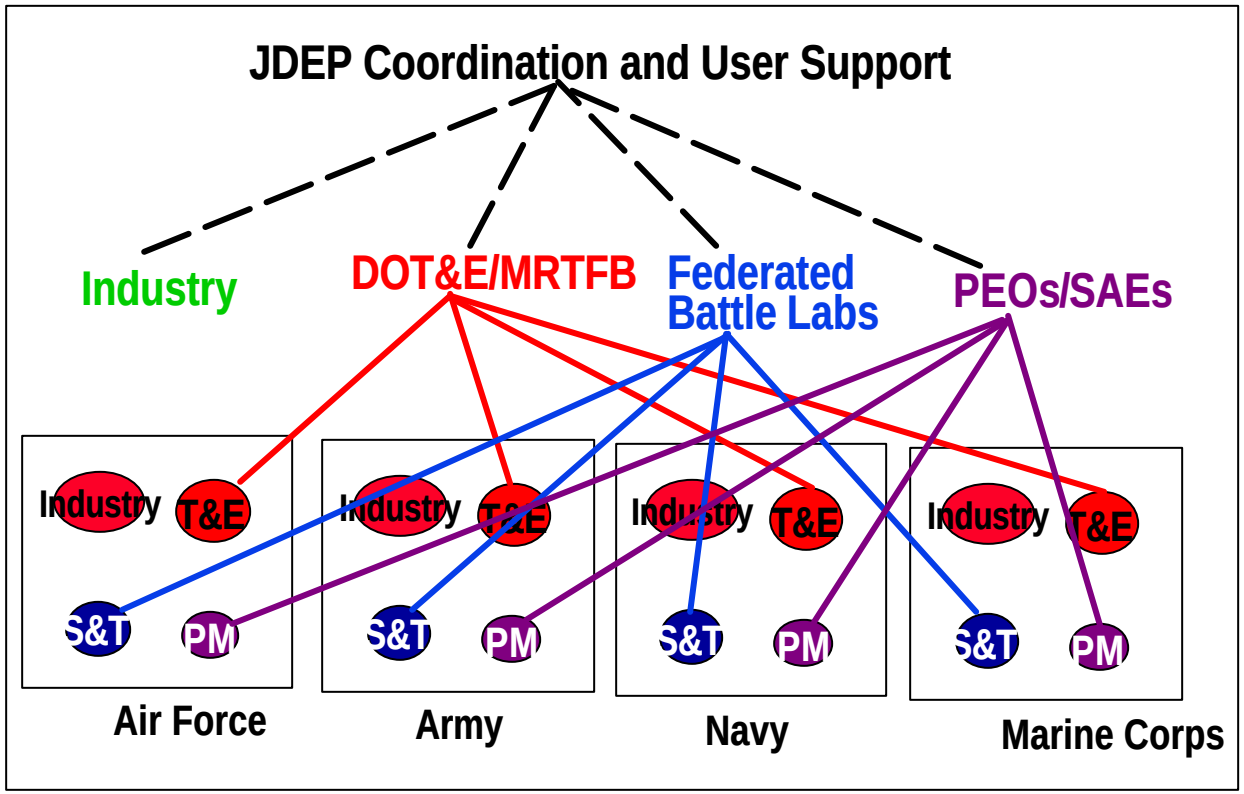
- **Present system integration evaluation capabilities good for what they do—limited performance assessment**
- **Need a capability to:**
  - **Support translation of user needs into design criteria**
  - **Identify and manage technical risk**
  - **Manage system interfaces**
- **Must be able to change operating environments and system algorithms during assessment periods to evaluate competing material solutions prior to fielding and for system upgrades**
  - **Sensitivity of performance based on perturbations to inputs**
  - **Rapid evaluation of system improvements to integrated performance**
  - **Measure performance against standardized metrics and operational contexts**

JDEP

" The JDEP program was established as a DoD-wide effort to link existing service and joint combat system engineering and test sites (including design activities, software support activities, test and evaluation facilities, training commands, and operational units). JDEP is designed to improve the interoperability of weapon systems and platforms through rigorous testing and evaluation in a replicated battlefield environment. "

[DPG Update FY 2002-2007, Guidance, p.112]

Purposes of JDEP



- JDEP supports three user communities
  - Developers to engineer interoperability into systems
  - Testers to test and evaluate interoperability among systems
  - Warfighters to assess operational capabilities of forces

By providing technical support to identify, access, and configure simulation and HWIL federations of SoS to meet users' needs

JDEP Strategy

- **Strategy** was developed and adopted in FY01
- **Purpose**
  - Guide JDEP organization and development to extend the capabilities of JDEP to support HW and SW in the loop integration and interoperability testing for applications across mission areas to meet needs of the developer, the tester and the war fighter
- **Key Ideas**
  - JDEP Capabilities
  - JDEP Events
  - JDEP Participants
  - JDEP Technical Framework

JDEP Capabilities and Events

- JDEP **capabilities** are
  - Simulations and HWIL/SWIL assets and processes,
  - owned by different organizations,
  - reused in different federations to address different SoS issues,
  - 'coordinated centrally' to support reuse and access by multiple users for different purposes

  Common across users; how they are used & for what purpose varies

- JDEP **events**
  - occur whenever JDEP components are 'federated' may be large or small with multiple events running concurrently
  - may not be a single event, but rather an ongoing event series

JDEP Participants

- JDEP **users** define the problems to be addressed by the JDEP federation and applies the results to meet their needs
- JDEP **providers** support users in several ways
  - **Coordination and technical support organization** helps users to identify, access, and configure assets and provides common tools and processes to meet their SoS needs
  - **Event conductors** direct specific events on behalf of users
  - **Suppliers** share their assets with different users to address SoS issues
- JDEP **management** looks across all JDEP uses and events to
  - Provide infrastructure investment,
  - Oversee asset coordination, and
  - Arbitrate access to scarce resources

JDEP Technical Framework

- **JDEP technical framework defines how components are 'composed' to create a 'federation' including**
  - The types and functions of components
  - The interfaces between components
  - Guidance on how to configure components into federations
- **Today different communities use different approaches**
  - Include, among others, Navy DEP, 'MDSE', 'D-Net', TENA
- **JDEP challenge is to define a framework to bridge communities**
  - Sufficient structure and standardization to get efficiency through ease of reuse and reconfigurability and
  - Sufficient flexibility to support different user needs and accommodate legacy capabilities with realistic investment

JDEP Technical Framework

Applications
Utilities
Partitioning of representation

Application interface
flexible support for data exchange and setup

Data exchange specification
conditions, syntax/semantics of data exchange

Information/data management
support efficient delivery, filtering, etc of data

Communications
local/area wide; physically move data

Commercial Utilities (IEEE 1561)

Representation Partitioned by Function

Flexible FOM, with setup data in FOM

Suite of extensible of Federation Object Models (IEEE 1516, Object Model Template)

HLA/RTI (IEEE 1516, Runtime Interface)
-- TENA Middleware

Industry standard communication services Defined for each application

Apply industry standards and commercial products to support federations of simulation and HWIL systems representations

SIAP and JDEP

- Air and Missile Defense is initial area for JDEP focus
- FY01, SIAP SE identified as initial customer
- FY01 Event
  - Navy DEP based, addressed subset of SIAP SE issues, identified gaps
  - Exercised process and offers source of lessons for future
- FY02 SIAP is highest priority JDEP user
  - MDSE nominated as host for SIAP events
  - Assessment showed similar tech issues as found with DEP
  - SIAP SE recommended no MDSE event
- Triggered direct discussions with SIAP SE on JDEP technical framework

SIAP SE and Analysis Approach

- SIAP needs reflect general requirements of JDEP users for system development and engineering
- SIAP SE process provides basis for JDEP HWIL
  - SIAP Integrated Analysis Plan (IAP) lays out approach to addressing issues across environments (Sim, HWIL, Live) using common metrics
  - Current SIAP issues have been articulated in terms which can be addressed through structured events (e.g. experiments)
  - Assessment of current and needed HWIL capabilities provides basis for planning for upgrades (e.g. FY01 POC event aka track 1)
- Hence JDEP offers a good tool for SIAP, and addressing SIAP engineering needs offers a good opportunity for JDEP

Long-term SIAP Federation

Utilities

Fed Manager
Viewer
Data Collector
Scenario Generator

Environment

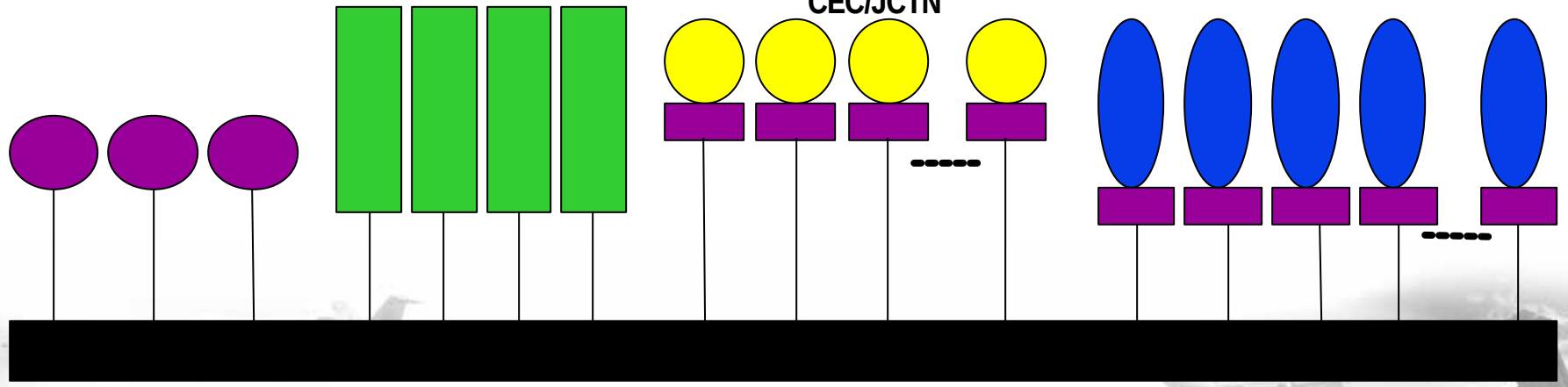
Electromagnetic
Physical
  Atmospheric
  Terrain
  Sea State

Simulations

Blue/Threat Systems
  Sensors
  Platform Movement
  Digital mission computers
  Weapons
Networks
  Link 16/11/etc.
  CEC/JCTN

HWIL

Blue Systems
  mission computers
enhanced inputs and outputs



SIAP Federation Development Strategy

- Assess ‘composite requirements’ of full set of experiments
  - Experiment/Requirements Matrix, begin with block1 issues
- In 02 develop and execute pilot federations as first step, addressing first set of critical issues
  - Take advantage of available components while building basis for iterative, spiral development
- In parallel, plan for future federation components
  - Including HWIL sim-stim enhancements, simulated system representations, sensor simulations and communications representations
- FY03, build on results of pilot federation with added components and added experiments

SIAP Plan to Use JDEP

- **Assess Effects of Time Synchronization and Sensor Registration Biases with Individual Systems (HWIL and Sim)**
  - **02: Patriot and E2C**
  - **03+: Added System (AWACS, TPS-59, F18, AEGIS, F15e)**
- **Assess Effects of Time Synchronization and Sensor Registration Biases with Integrated Systems of Systems**
  - **Incrementally 'suites' of systems**
  - **03: Conduct Patriot/E-2C Combined Federation for Time Synchronization and Sensor Registration Experiments**
- **Investigate Implementation Options for Components of Framework for SIAP Domain**

Digital System Representations

JDEP includes digital system representations as well as HWIL

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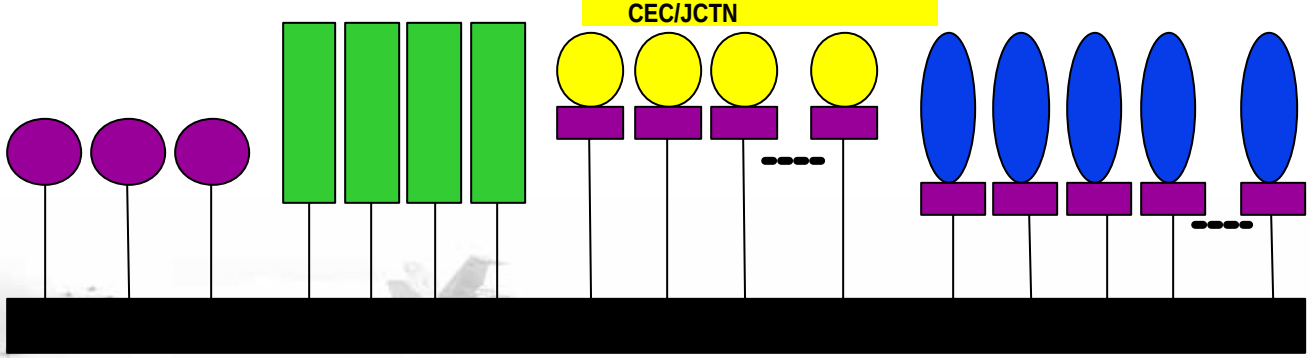
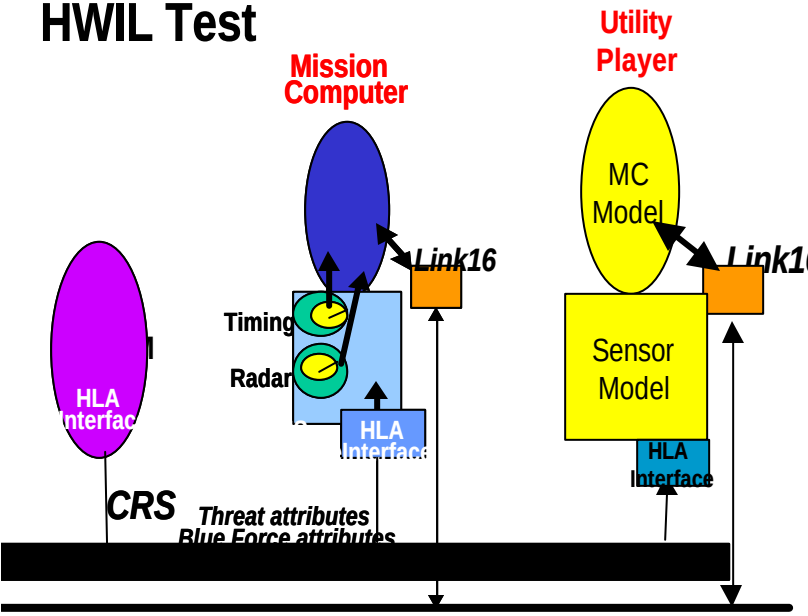


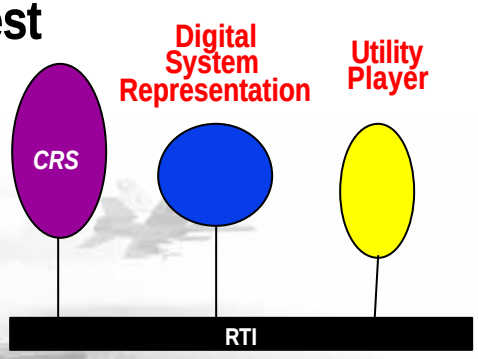
- Allow for flexibility and efficiency
- Provides opportunity for assessing impacts of proposed, vice implemented, capabilities
- Supports development as well as test

Sensor Registration & Time Synchronization Bias Effects on Systems

HWIL Test



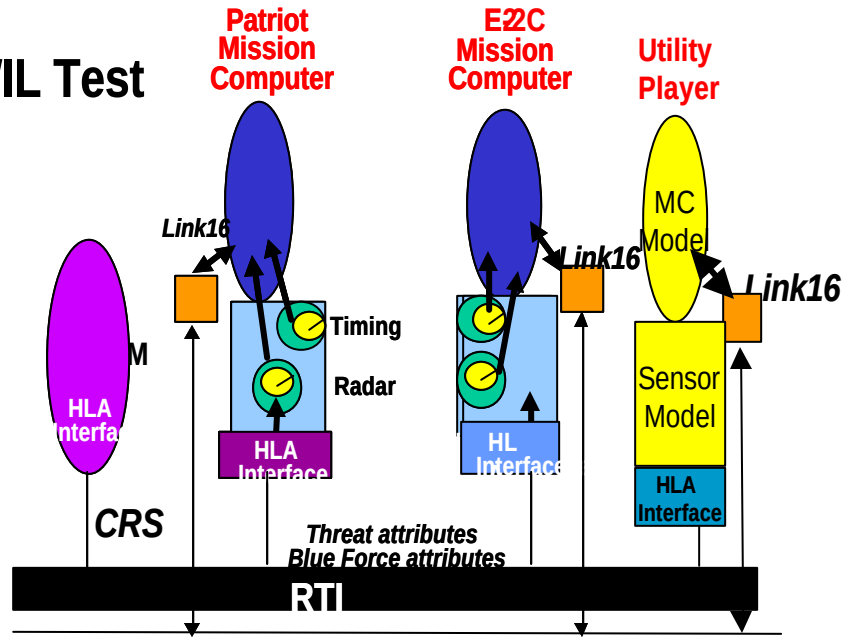
Simulation Test



- Objective is to conduct experiments to address the effects of biases on systems
- Apply SIAP common reference scenario and attributes
- Upgrade system (HWIL and digital system representation) to add biasing and operate in framework
- Events conducted with each system to
  - Verify system Upgrade
  - Quantify Effects on Track Quality for each system
  - Quantify Effects on Track Correlation for each system
  - Cross validate simulation results
- Data will support Block 1 analyses

Sensor Registration & Time Synchronization Bias Effects on Systems of Systems

HWIL Test



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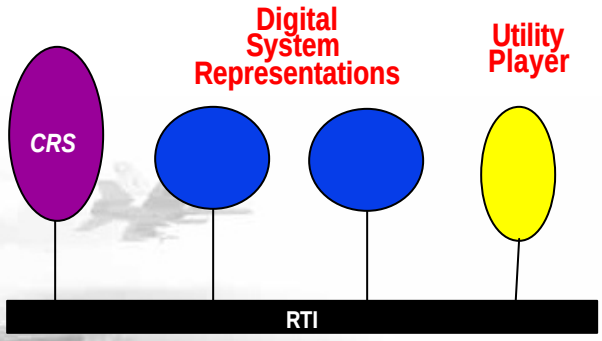
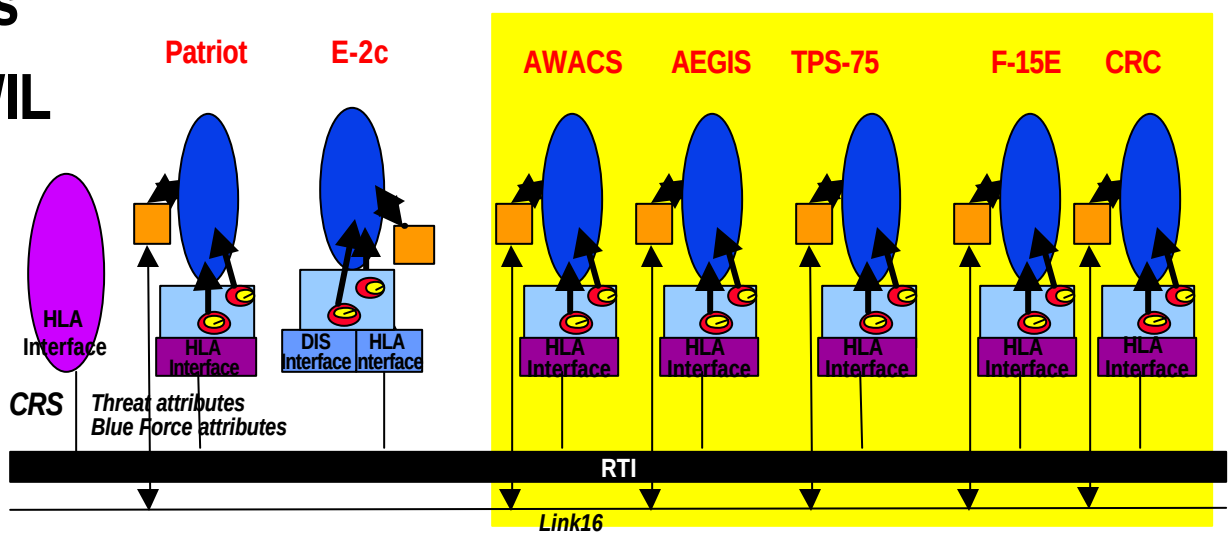


- Objective is to conduct experiments to address the effects of biases on systems
- Apply SIAP common reference scenario and attributes
- Incorporate systems (HWIL and digital system representation) which have been upgraded to add biasing and operate in framework
- Events conducted with suites of systems
  - Quantify Effects on Track Quality for systems working together
  - Quantify Effects on Track Correlation for systems working together
  - Validate simulation results
- Data will support Block 1 analyses

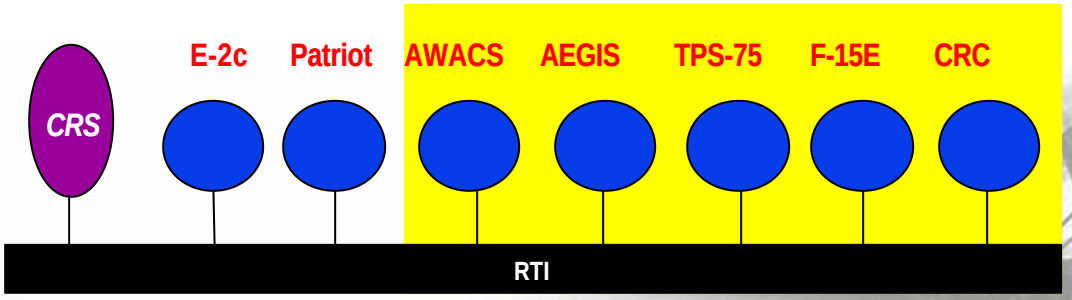
Follow-on: Added Systems HWIL and Simulations

- Upgrade and incorporate added HWILS and digital system representations (AEGIS, TP59, AWACS, F-15, CRC...) for FY03 events using the bias insertion and interface approach best suited to those systems

HWIL

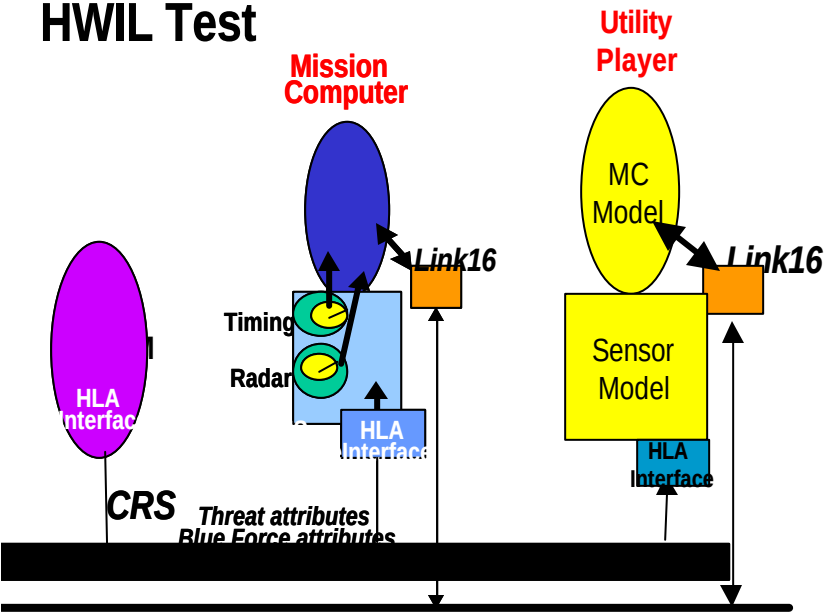


Simulations

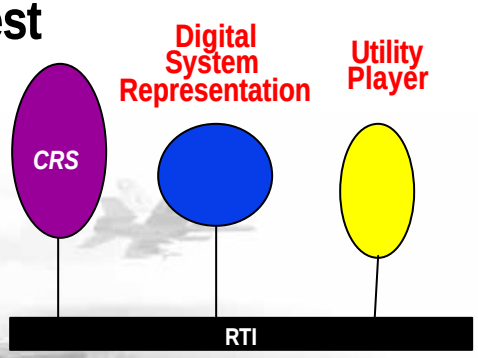


Added Experiments with Individual Systems

HWIL Test



Simulation Test



- Objective is to conduct experiments to address the other SIAP Experiments
  - PPLI, Correlation/Decorrelation, TQI, CID
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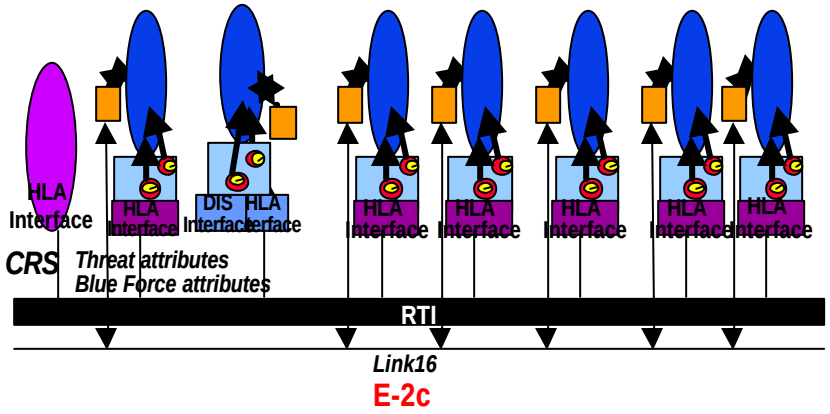
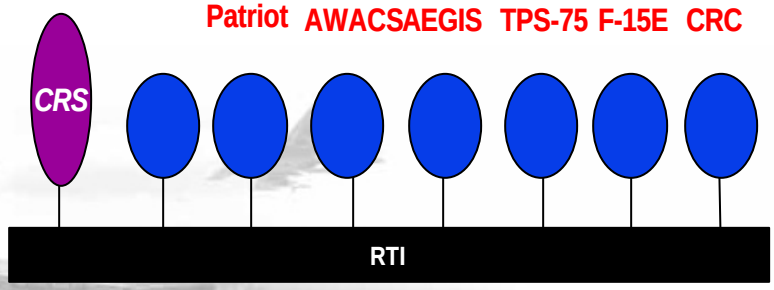
Added Experiments with Systems of Systems

HWIL



Simulations



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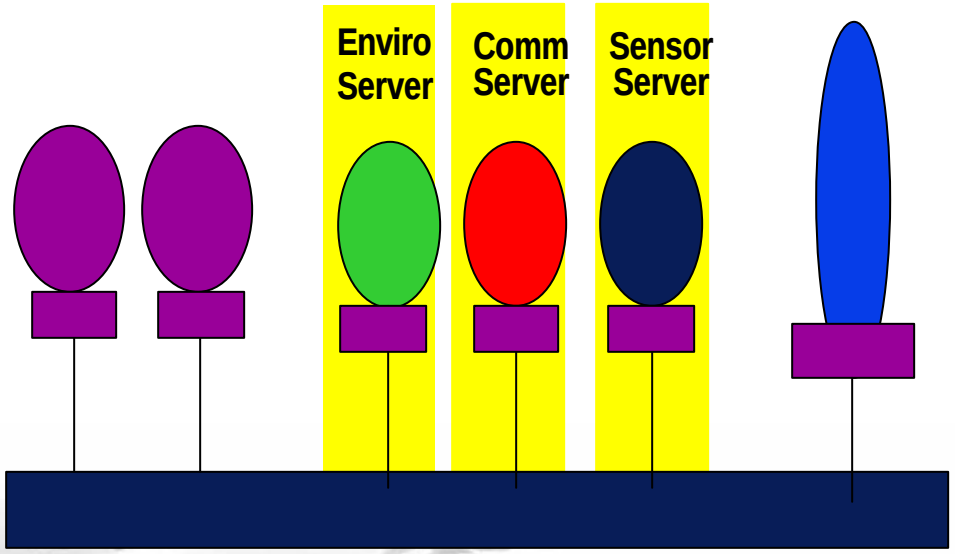
Added Components of Framework

Potential Future Federation Components



- JDEP framework identifies additional components of a federation which could increase fidelity and flexibility to address issues
- An assessment of the viability and utility of these will be conducted
  - Communications Server
  - Sensor Server
  - Environment Server

SIAP Strategy for Use of JDEP

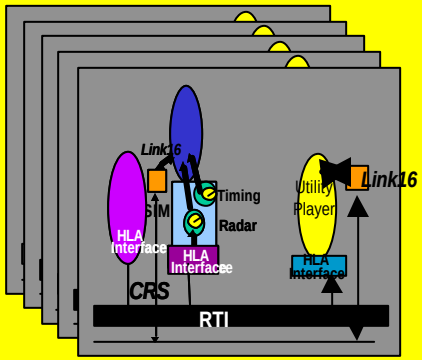
SIAP Producing Systems

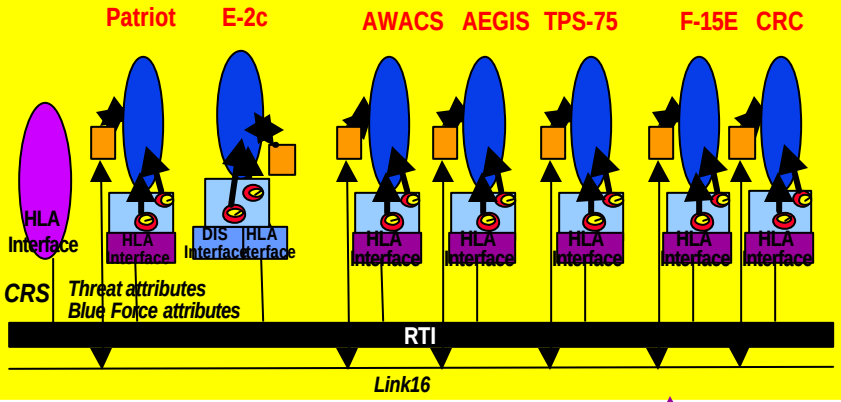
AWACS
AEGIS
AN/TPS-75
F15-E
CRC

SIAP Experiments

Time Synchronization
Data Registration
PPLI
Correlation/Decorrelation
CID

Hardware-In-The-Loop Representations



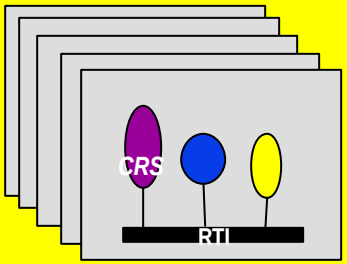


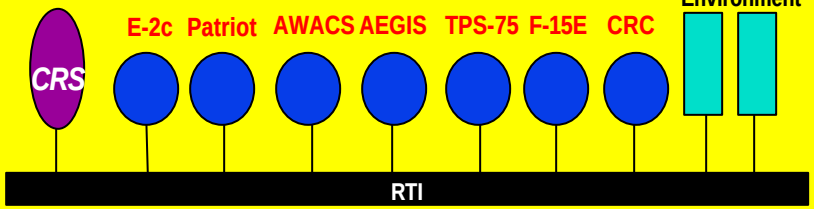
Environment for Sensitivity and Root Cause Analysis

Cross Validation

Cross Validation

Digital (Simulated) Representations





Environment for Validation of Upgrades and Architecture

JDEP 'leave behind' capabilities:

Scenario server
Federation utilities
System representations
Network nodes
Event planning processes
Plan and report templates